

Application No. 09/751,090

REMARKS

The above-identified patent application has been reviewed in light of the Office Action dated September 2, 2004. Claims 1, 2-6, 9, 13 and 14 have been amended, and Claim 8 has been canceled, without intending to abandon or to dedicate to the public any patentable subject matter. Claims 21-24 are new. Accordingly, Claims 1-7, and 9-24 are now pending. As set out more fully below, reconsideration and withdrawal of the objections to and rejections of the claims are respectfully requested.

Claims 1-8, 10-12, 14, and 16-19 stand rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 6,243,827 B1 to Renner, Jr. in view of U.S. Patent No. 5,974,544 to Jeffries; Claim 13 stands rejected under 35 U.S.C. § 103 as being unpatentable over Renner in view of Jeffries and further in view of U.S. Patent No. 5,479,653 to Jones; and Claim 9 stands rejected under 35 U.S.C. § 103 as being unpatentable over Renner in view of Jeffries and further in view of U.S. Patent No. 6,353,895 to Stephenson. In order to establish a prima facie case of obviousness under Section 103, there must be some suggestion or motivation to modify the reference or to combine the reference teachings, there must be a reasonable expectation of success, and the prior art reference or references must teach or suggest all of the claim limitations. (MPEP § 2143.) However, each and every element of the claims cannot be found in the cited references. Therefore, reconsideration and withdrawal of the rejections of Claims 1-14 and 16-19 as obvious are respectfully requested.

The present invention generally provides for a method or mechanism for controlling an array of storage devices in response to a failure of one or more of the storage devices included in the array. In particular, the present invention provides a trust array command that enables user data to be read from any storage device within an array, including storage devices that were indicated as being unavailable, following the detection of a fault with respect to the array. This is in contrast to typical storage array systems that emphasize safeguarding data with respect to mission critical applications by initiating procedures to recreate and restore data in response to the detection of a failure in an array. Therefore, while typical RAID systems require time

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consuming reconstruction procedures, the claimed invention permits user data on any storage device within an array to be accessed following a failure, provided that all of the storage devices within the array are in communication with the controller following the failure. In addition to allowing data to be accessed without requiring reconstruction, the claimed invention does not require that the RAID array level or configuration be changed. Therefore, it can be appreciated that embodiments of the present invention favor timely access to data over safeguarding data. The prior art references do not disclose these features.

The Renner Jr. patent is generally directed to multiple channel failure detection in RAID systems, and describes procedures for handling data when there are one or more invalid regions on one or more disks of an array. Physically or logically invalid regions of disks are identified, and the addresses and links of each invalid region are written to a bad region table. The bad region table is provided on disks of the array. The re-use of a previously failed disk, without restoring or reallocating user data and without changing the RAID array configuration, is not described by Renner. Instead, the system of Renner requires reconstruction of data in order to restore the array to redundancy. (Renner, col. 12, ll. 42-45.)

The Jeffries patent is generally directed to a method and controller for defect tracking in a redundant array. In particular, Jeffries discusses a process that marks a drive as bad and never attempts to access it again if it determines that the drive has failed completely. (Jeffries, col. 16, ll. 38-40.) Jeffries does not describe reusing a failed drive in an array without reconstructing or reallocating data. For example, Jeffries states: "to reuse a drive which has previously failed, the diagnostics must be used to erase the drive's DDA sector." (Jeffries, col. 16, ll. 54-56.) In addition, Jeffries requires that: "after the failed drive has been replaced, a DDA will rebuild the failed drive's data on the new drive. . . ." (Jeffries, col. 16, ll. 57-58.) Accordingly, the re-use of a storage device after a failure, without reallocating or restoring data, is not described by Jeffries.

The Jones patent relates to modifying a RAID configuration when one or more disk drives of an array fail. The array is initially configured for optimum performance. If it is determined that a disk drive has failed, the array is automatically reconfigured to a different

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RAID configuration using a lesser number of drives. (Jones, col. 3, ll. 16-20, 27-30 and 48-57.) Accordingly, the Jones patent does not teach, suggest or disclose accessing data in an array after discontinuing use based on a failure without changing the original RAID level or configuration to another RAID level or configuration. Instead, Jones specifically requires that as failures occur, the array system reconfigures to other RAID configurations that utilize less data redundancy and thus require a lesser number of drives. (Jeffries, col. 3, ll. 16-20.)

The Stephenson reference is generally directed to a RAID architecture with two drive fault tolerance. In particular, Stephenson discusses accomplishing data recovery from a one or two drive failure by using a two-dimensional XOR parity arrangement. (Stephenson, col. 2, ll. 40-42.) However, Stephenson does not discuss reusing drives included in a storage array without reconstructing or reallocating data. Instead, Stephenson reconstructs data that was stored on a failed drive from parity information stored on other drives in the array. (See, e.g., Stephenson, col. 5, ll. 63-67.)

Claim 1 is generally directed to a method for reusing an array of storage devices. As amended, Claim 1 recites "using firstly an array of storage devices arranged in a first RAID level configuration." In addition, Claim 1 recites "ascertaining that a failure has occurred; [and] discontinuing use of at least one of said storage devices of said array . . . based on the failure." Furthermore, amended Claim 1 recites:

using each storage device included in said array of storage devices
after said discontinuing wherein said using said array of storage
devices after said discontinuing includes accessing user data in said
array of storage devices without restoring or reallocating any of
said user data and without changing said first RAID level
configuration to another RAID level configuration.

Support for such amendment can be found in the Specification, for example at p. 10, ll. 7-15. A disclosure of such features is not made by the Renner or Jeffries patents. In particular, the cited references do not teach, suggest or disclose reusing storage devices after a failure, without restoring or reconstructing user data, as recited by Claim 1. Furthermore, such deficiencies in the Renner and Jeffries references are not made up by either the Jones or the Stephenson reference.

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Accordingly, for at least these reasons, the rejection of Claim 1 should be reconsidered and withdrawn.

Claim 14 is generally directed to a system in which an array of storage devices are reused after use of at least one storage device of the array is discontinued based on a fault. In particular, Claim 14 recites a host that is used in generating a trust array command related to updating metadata, including changing the metadata from indicating that the one or more storage devices is inaccessible to indicating that the one or more storage devices is accessible after a fault and after use of the array was discontinued due to the fault. Furthermore, amended Claim 14 recites that the array has a first array configuration both before and after the fault, and in which after the trust array command is generated user data stored on the storage devices is accessible in its original form, without restoration or recreation of said user data. Neither the Renner nor the Jeffries reference describes such a system. For instance, neither Renner nor Jeffries teaches, suggests or discloses accessing data on a previously failed storage device without restoration or recreation of data. Furthermore, the deficiencies of the Renner and Jeffries references are not made up by any other of the cited references. Accordingly, for at least these reasons, the rejection of Claim 14 and the claims dependent therefrom as obvious should be reconsidered and withdrawn.

New Claim 21 is generally directed to a method for controlling an array of storage devices. According to Claim 21, data is stored in accordance with a first RAID level. Claim 21 also recites receiving a trust array command after a fault has been detected. In response to the trust array command, data is at least one of stored to and read from each storage device included in the array, without restoring any data stored in each of the storage devices. Support for Claim 21 and dependent Claims 22-23 can be found in the Specification, for example at p. 5, ll. 6-14; p. 6, ll. 2-15; and p. 10, ll. 7-15. As noted above, the Renner and Jeffries references require reconstruction or restoration of data after a fault. Furthermore, the Jones reference requires a change in the RAID level of the array after a fault. The Stephenson reference discusses

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reconstructing data using parity information. Therefore, for at least these reasons, new Claim 21 and Claims 22-24, which depend from Claim 21, are allowable over the cited references.

Applicant notes with appreciation the Examiner's indication that Claim 15 would be allowable if rewritten in independent form to include all of the limitations of the base claim and any intervening claims. However, it is submitted that in view of the amendments and remarks set forth herein Claim 15 is now in condition for allowance. Accordingly, Applicant respectfully requests that the objection to Claim 15 be reconsidered and withdrawn.

Applicant additionally notes with appreciation the Examiner's indication that Claim 20 is allowed.

The application now appearing to be in form for allowance, early notification of same is respectfully requested. The Examiner is invited to contact the undersigned by telephone if doing so would expedite the resolution of this case.

Respectfully submitted,

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Date: November 17, 2004